

Brookhaven National Laboratory/National Synchrotron Light Source				
<b>Subject:</b>	<b>LINAC-Booster Radiological Interlock Test</b>			
<b>Number:</b>	LS-PPS-0013	<b>Revision:</b>	E	<b>Effective:</b> 5/23/06 <b>Page 1 of 12</b>

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\*Approval signatures on file with master copy.

[Revision/Periodic Review Log](#)

Test Reason:	Test Result: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	
	Test Type: <input type="checkbox"/> Full <input type="checkbox"/> Partial	
Test Date:	Start Time:	Finish Time:
Tester 1:	Assistant 1:	
Tester 2:	Assistant 2:	

#### Definitions:

CS = Check Station Button

IP = Test Person Inside Tunnel

OP = Test Person Outside Tunnel

ES = Emergency Stop Button

SRU = Solenoid Key Release Unit

DG = Door Guard Button

#### PREPARATION:

- Inform Machine Operator that test will be done.
- Assure Modulators are ready to operate.
- LOTO LINAC low level RF and Low Level Beam Transport (LEBT) valve. Refer to procedure "[LINAC LOTO](#)", [LS-ESH-0012](#)".
- Sign out "SR8 LINAC/Booster Security" key from control room.
- Refer to [Figure 1](#) (Injection Control Panel) and [Figure 2](#) (LINAC/Booster Layout) as a reference to component location.

1. **Search Sequence:** Secure the LINAC/Booster area.

#### Search sequence

Close Doors and press reset at SR8;

Press DG;

Press (Start Search);

Press CS-1;

Press DG;

Open Entry Door, Exit, & Close door;

Insert key in SRU and rotate into position;

Press CS-E (Search Complete)

After the time-out, interlock A is satisfied on all three modulators

\_\_\_\_\_

The modulators do not turn on by themselves

\_\_\_\_\_

On the Control Room Shutter Control Panel, the:

Green LINAC/Booster Enable light is OFF

The Red Disable light is ON

\_\_\_\_\_

“Area interlock” indicator is ON in control room;

\_\_\_\_\_

“Kirk Key Secure” indicator is ON in control room

\_\_\_\_\_

Turn Modulator High Voltage ON via NSLS Pretune

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2. Press the LINAC/Booster Enable Button

The button enable light comes ON

The B interlock on the modulators is ON

The three modulators turn on

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Break security pressing the Interlock OFF button.

Three modulators turn OFF

Press LINAC/Booster Enable button.

The Red Disable light stays ON

The Green Enable light stays OFF

Attempt to turn ON modulators via Pretune.

The modulators stay OFF

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. Press CS-E (outside access door).

Interlock does not activate

Remove key from SRU

“Kirk Key Secure” indicator turns OFF in Control Room

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. One person (IP) goes into tunnel. OP Closes access door, places Kirk Keys in SRU, and rotates keys. IP presses the DG button then the Start Search button (inside LINAC bending magnet cave).

The Start Search light goes ON.

OP presses CS-E.

Interlock does not activate

OP opens the LINAC Door.

Light ON Start Search goes out

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

6. Close the LINAC Door remove and place Kirk Keys in the SRU, rotate keys.

IP presses DG then Start Search button and notes time.

IP then presses CS-1 (on south wall of booster).

All Five strobe lights turn ON

Time until the light ON the Start Search button box goes out is not more than 3 minutes.

All Five strobe lights turn OFF

OP presses CS-E

Interlock does not activate

OP Removes Kirk Keys and opens the LINAC Door. Close the LINAC Door.

Remove and place Kirk Keys in the SRU. Rotate keys.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_

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7. IP presses DG then CS-1. OP presses CS-E.  
Interlock does not activate \_\_\_\_\_
  
- IP presses Start Search then CS-1. OP presses CS-E  
Audible Alarm Sounds \_\_\_\_\_
  
- OP Removes Kirk Keys (using the SRU bypass key) and opens the LINAC Door.  
Audible alarm stops \_\_\_\_\_
- OP closes the LINAC Door removes and places Kirk Keys in the SRU and rotates keys. OP immediately presses CS-E again.  
Interlock does not activate \_\_\_\_\_
8. Search the LINAC-Booster; IP remains at booster door without going inside the Booster Area. After completing search and returning key to SRU, OP goes to LINAC modulators. \_\_\_\_\_
- Interlock light labeled "A Enable" for each mod does not come on until after warning period. \_\_\_\_\_
- IP times audible warning. \_\_\_\_\_
- Warning sounds properly and lasts for at least 30 seconds. \_\_\_\_\_ sec.
  
- Press the Modulator Enable in the control room.
  
9. Enter LINAC. Close the LINAC door, IP presses DG, Start Search, and then CS-1  
DG light is ON \_\_\_\_\_
- "Interlocked" Sign comes ON \_\_\_\_\_
- OP opens the LINAC door.  
"Interlocked" Sign goes out \_\_\_\_\_
- DG light goes out \_\_\_\_\_
- OP closes the LINAC door and removes the Kirk keys, inserts them in the SRU and rotates them, OP presses CS-E  
Interlock does not activate. \_\_\_\_\_

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10. **Emergency Stop Test:**

Emergency Stop Switch	Location
ES1	Located on wall behind Gun Tank
ES2	Outside of LINAC bending magnet cave
ES3*	Cable runs along the top of the X-Ray tunnel, the switch is located above the x-ray transport line
ES4	East wall of booster, side towards control room
ES5	West wall of booster, side towards x-ray ring
ES6	Center of booster ring

*\*Note: For ES3 – pull cable to activate switch. Press button on switch to reset.*

Press an Emergency Stop button

(Test ES switches ES1 - ES6 separately)

	<u>ES1</u>	<u>ES2</u>	<u>ES3</u>	<u>ES4</u>	<u>ES5</u>	<u>ES6</u>
Emergency Stop 'A' light on SR8 goes out	_____	_____	_____	_____	_____	_____
Emergency Stop 'B' light on SR8 goes out	_____	_____	_____	_____	_____	_____
Emergency Stop Latch light goes out	_____	_____	_____	_____	_____	_____
Reset/Pull out ES switch						
Emergency Stop 'A' light on SR8 comes ON	_____	_____	_____	_____	_____	_____
Emergency Stop 'B' light on SR8 comes ON	_____	_____	_____	_____	_____	_____
The Emergency Stop Latch light stays OFF	_____	_____	_____	_____	_____	_____
Press the Reset button at SR8						
The Emergency Stop Latch light comes ON	_____	_____	_____	_____	_____	_____

**NOTE:** The next two tests will crash the X-ray and VUV ring interlocks. Check that this will not interfere with activities in those areas.

11. A person must watch the emergency stop light on the x-ray security rack at the center of the x-ray ring.

Press ES-CRX (x-ray-injector crash button in the control room).

Emergency Stop 'A' and 'B' light at LINAC security rack SR8 goes out	_____	_____
Emergency Stop Latch 'A' Light goes out at SR8	_____	_____
X-Ray system Emergency Stop light goes out at SR100	_____	_____
Pull ES-CRX back out		
Emergency Stop 'A' and 'B' light at LINAC security rack SR8 comes ON	_____	_____
Emergency Stop Latch 'A' Light stays OFF at SR8	_____	_____
X-Ray system Emergency Stop light comes on at SR100	_____	_____
Press the Reset button at SR8		
Emergency Stop Latch 'A' Light comes ON at SR8	_____	_____

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12. A person must watch the emergency stop light on the UV ring security rack in the UV ring.

Press the ES-CRU (UV-injector crash button in the control room).

Emergency Stop 'A' and 'B' light at LINAC security rack SR8 goes out

Emergency Stop Latch 'A' Light goes out at SR8

Emergency Stop latch 'A' & 'B' light goes out at SR9 in VUV ring.

Emergency Stop 'A' & 'B' light goes out at SR9 in VUV ring.

Pull ES-CRU back out

Emergency Stop 'A' and 'B' light at LINAC security rack SR8 comes ON

Emergency Stop Latch 'A' Light stays OFF at SR8

Emergency Stop latch 'A' & 'B' light stays out at SR9 in VUV ring.

Emergency Stop 'A' & 'B' light comes ON at SR9 in VUV ring.

Press the Reset button at SR8 at LINAC.

Emergency Stop Latch 'A' Light comes ON at SR8

Press the Reset button at SR9 in VUV ring.

Emergency Stop latch 'A' & 'B' light comes ON at SR9 in VUV ring.

13. Search the LINAC-booster. Turn ON the modulators. Press E-Stop #7 on the booster security rack LA1SR8.

All three modulators turn OFF

"A enable" and "B enable" lights are OFF

Reset the Emergency Stop and the Emergency Stop Latch.

**Caution:**

**Do Not allow personnel in the LINAC/Booster area with the Modulators ON**

14. **Booster Door test:**

Obtain booster door key from SRU, open booster door and place "latch device" on lock so key can be removed with door open. Place a "switch holder" on each door switch. OP returns key to SRU.

Booster Door Closed 'A' light is ON

OP presses reset button.

Booster Door Latch 'A' light comes ON

Search LINAC-Booster.

IP removes holder from #2 Door switch.

The Booster Secure B light goes out

IP replaces switch holder #2

The Booster Secure B light remains out

OP resets the B chain with the RIB Test Key

The Booster Secure B light is ON

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- IP removes holder from #1 Door switch.
- Booster Door Latch 'A' light goes out \_\_\_\_\_
- Booster Door Closed light goes out \_\_\_\_\_
- LINAC-Booster Interlock drops out \_\_\_\_\_
- IP replaces switch holder #1
- Booster Door Closed 'A' light comes ON \_\_\_\_\_
- The Booster Door Latch 'A' light remains out \_\_\_\_\_
- OP presses the Reset button at LA1SR8
- The Booster Door Latch 'A' light comes ON \_\_\_\_\_
15. IP presses DG, Start Search button and CS-1.
- Start Search & CS-1 lights come ON \_\_\_\_\_
- IP removes holder from the #1 switch and replaces it. OP presses CS-E.
- Interlock does not activate \_\_\_\_\_
- Start Search & CS-1 lights go out \_\_\_\_\_
- All five strobe lights go out \_\_\_\_\_
- Reset the Booster Door Latch.
- Search LINAC/Booster
- All personnel remain outside of the LINAC/Booster area.**
16. Turn all three modulators ON if they are not already ON. IP removes the holder from booster door switch #2.
- All modulators turn OFF \_\_\_\_\_
- "B enable" light is out and "A enable" light is ON \_\_\_\_\_
- Booster Secure "B" light turns OFF \_\_\_\_\_
- Replace holder on switch #2
- 'B' Enable on all three modulators stays out. \_\_\_\_\_
- Booster Secure "B" light stays OFF \_\_\_\_\_
- Reset RIB
- Booster Secure "B" light turns ON \_\_\_\_\_
17. Turn all three modulators ON. IP removes the holder from booster door switch #1.
- All modulators turn OFF \_\_\_\_\_
- "A enable" lights are OFF \_\_\_\_\_
- "B enable" lights are ON. \_\_\_\_\_
- Replace the holder on switch #1 and reset booster door latch at SR8.
18. Obtain Kirk key for booster door. Remove switch holders and latch device from door. Open and close door and observe switches.
- Both switches operate freely and each clicks when door is opened \_\_\_\_\_
19. OP returns key to SRU and resets booster door latch at SR8.
- Booster door latch 'A' light comes ON \_\_\_\_\_

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20. **LINAC Door Test:**

Open LINAC door. Place latch device on lock and holders on door switches.

Return Kirk key to SRU. Search the LINAC – Booster.

LINAC Door Closed 'A' is ON

Booster Secure 'A' and 'B' are ON

Turn ON the modulators.

All three modulators are ON

Remove the holder from switch #2

All three modulators turn OFF

'B Enable' goes out on all three Modulators

Booster Secure 'B' light goes out

Replace the holder and press CS-E

Attempt to Turn ON modulators

'B Enable' stays OFF on all three Modulators

Booster Secure 'B' light stays out

Reset the 'B' chain with the RIB Test Key

Booster Secure 'B' light comes ON

Turn ON the modulators.

Remove the holder from switch #1

All three Modulators turn OFF

'A Enable' light goes out on modulators

Booster Secure 'A' light goes out

LINAC Door Closed 'A' is out

Interlock drops out

Replace the switch holder and press CS-E

'A Enable' stays OFF on all three Modulators

Booster Secure 'A' stays out

LINAC Door Closed 'A' is ON

Booster Secure 'B' is ON

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21. **Door Switches/Power Supplies:**

**CAUTION**

**Guard the access door to ensure that no one enters tunnel  
and contacts magnet conductors.**

Search LINAC-Booster.

Turn ON modulators, booster dipole, quadrupole, sextupole power supplies, and Kicker supplies listed below.

Note: The Gun will need to be turned ON for some of the kicker supplies to turn ON. The Machine Operator will also need to switch to X-Ray or VUV extraction mode.

Remove holder from **switch #2**

Modulator "A enable" lights are ON all  
Three modulators  
Modulator "B enable" lights are OFF  
all Three modulators  
Dipole supply turns OFF  
Quadrupole supply turns OFF  
Sextupole supply turns OFF

Verify the following kicker supplies remain On:

LBIFB1  
LBIFB2  
LBISH  
BXSBLW  
BXESH1  
BXESH2  
BXEKF  
BUSBLW  
BUESH1  
BUESH2  
BUEKF

**X-Ray Mode**

**VUV Mode**

Not In Use

Replace holder on **switch #2**.

Reset the B chain using the RIB Test Key.

Turn ON modulators, booster dipole, quadrupole, and sextupole power supplies, and Kicker supplies listed below.

Note: The Gun will need to be turned ON for some of the kicker supplies to turn ON.

Remove holder from **switch 1**.

All three modulators turn OFF  
Modulator "A enable" lights are OFF  
on all Three modulators  
Modulator "B enable" lights are ON all  
Three modulators.  
Dipole supply turns OFF  
Quadrupole supply turns OFF  
Sextupole supply turns OFF

**X-Ray Mode**

**VUV Mode**

(Step 21 cont. next page)



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Verify the following supplies turn OFF:

LBIFB1	_____	_____
LBIFB2	_____	_____
LBISH	_____	_____
BXSBLW	_____	_____
BXESH1	_____	_____
BXESH2	_____	_____
BXEKF	_____	_____
BUSBLW	_____	_____
BUESH1	_____	_____
BUESH2	_____	_____
BUEKF	_____	_____

22. **Solenoid Release Unit (SRU):**

- With Kirk keys captured in SRU, turn key and observe where the solenoid stops key rotation.
- Press solenoid release button and turn key just past this point, but not far enough to actuate "key removed switch". Release button and leave key in this position.
- Search LINAC-booster and guard access door to prevent anyone from entering and contacting magnet conductors.
- Turn ON modulators, booster dipole, quad, and sextupole power supplies. Turn the Kirk key fully CCW and remove.

All three modulators turn OFF	_____	_____	_____
Modulator 'B Enable' lights turn OFF	_____	_____	_____
Modulator "A enable" lights stay ON	_____	_____	_____
Dipole supply turns OFF	_____	_____	_____
Quadrupole supply turns OFF	_____	_____	_____
Sextupole supply turns OFF	_____	_____	_____
The Booster Secure 'B' light is out	_____	_____	_____
The Kirk Keys Secured light in the control room and the security rack are out.	_____	_____	_____

Rotate the Kirk Key CW fully and press CS-E

The Booster Secure 'B' light stays OFF	_____	_____	_____
The Kirk Keys Secured light is ON in the control room and at the security rack	_____	_____	_____

Reset the B chain using the RIB Test Key.

The Kirk Keys cannot be removed with Booster B chain secured.	_____	_____	_____
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23. **Magnet Test Key:** Turn ON modulators and Booster Main power supplies.

Magnet Test Kirk Key Normal light is ON	_____	_____	_____
---	-------	-------	-------

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Remove "Magnet Test" Kirk key.

Three modulators turn OFF

"A enable" and "B enable" lights are OFF

Dipole supply turns OFF

Quad supply turns OFF

Sextupole supply turns OFF

Magnet Test Kirk Key Test light is ON

Booster Secure 'A' and 'B' are out

Attempt to secure the Booster.

The area does not secure.

Replace the "Magnet Test" Kirk Key.

Booster Secure 'A' and 'B' remain out

The Magnet Test Kirk Key can only be removed in the TEST position

Replace "Magnet Test" Kirk key and place in Normal Mode.

24. **Lockout Switch:**

Search the LINAC area and turn ON the modulators.

Rotate the lockout switch to OFF.

All three modulators turn OFF

Booster secure 'A' and 'B' are out

"A enable" and "B enable" lights are OFF

Attempt to secure the booster with the lockout switch in the OFF position.

Booster does not secure

Attempt to turn ON the modulators

All three modulators remain OFF

Rotate the lockout switch to 'ON'.

25. Remove latch unit and switch holders from LINAC door. Open and close door and observe switches.

Both switches operate freely and each makes a click sound when door is opened

Take custody of the KK Test/RIB reset Key

Return SR8 LINAC/Booster Security key to Control Room

26. Remove red tags and turn ON or plug in pulsed amplifier and open LEBT valve. Inform Machine Operator that LINAC-Booster test is complete and request that a notation be made in the shift log.



Figure 1: Injection Control Panel (located at Operator's Console)

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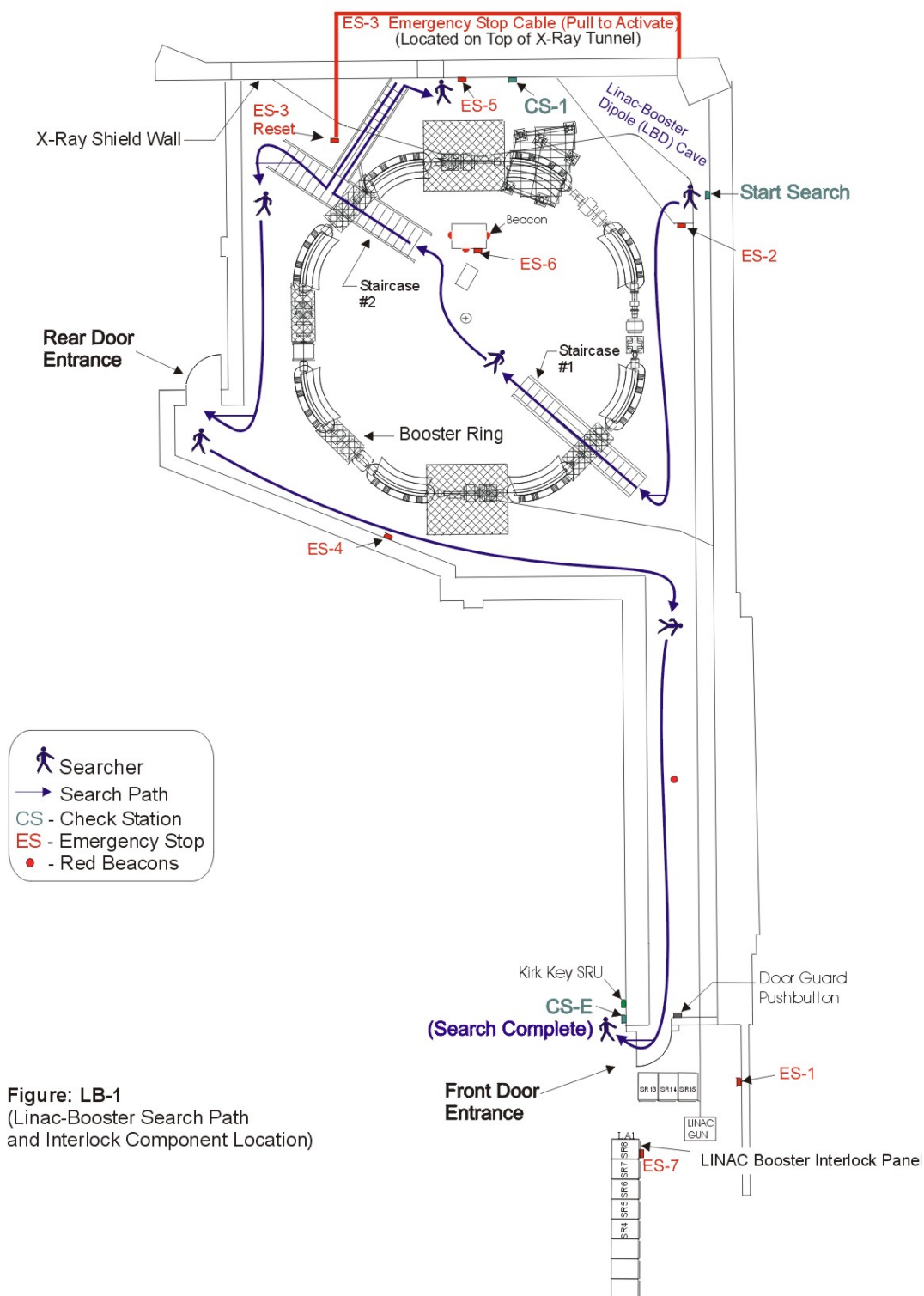


Figure: LB-1  
(Linac-Booster Search Path  
and Interlock Component Location)

Figure 2: LINAC-Booster Layout

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